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## SECURING EFFICIENCY THROUGH A STANDARD TESTING LABORATORY

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BY OTTO H. KLEIN,

Director, Standard Testing Laboratory, City of New York.

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The establishment of a municipal laboratory for the purpose of testing materials used or intended to be used in the construction of public improvements, and also supplies furnished to public institutions, is by no means an undertaking of recent date. Such laboratories have been in existence for many years, especially in the capital cities of Europe. In America, however, the importance of a municipal testing laboratory has only been given its deserved recognition for a decade, more or less. It developed principally from the desire of the paving engineer to keep a check on the various materials used in the construction of pavements in his city. And these laboratories, as a rule, were poorly equipped and were hardly able to control the street work in course of construction, to say nothing of conducting research work.

At the time of the consolidation of the greater City of New York in 1898, only two small city-owned laboratories, devoted to the examination of materials of construction, existed, and these were only designed to conduct examinations of cements and asphalts. Only two boroughs of the greater City of New York at the present time have small laboratories which are able to undertake the physical and chemical examination of the paving materials used in the construction of their streets. The officials of the remaining three boroughs have gradually discovered the necessity of testing their cements and paving blocks, and the consequence was the establishment of small testing stations in their boroughs, principally confined to physical tests of cements, while chemical analyses of paving materials had to be entrusted to private analytical chemists not in the regular employ of the City of New York.

As increasing improvements—the big bridge, water works, subways, docks, ferry service, etc.—developed, the examination of materials of construction became most imperative. Yet it remained the policy of the officials of the City of New York to confine the scien-

tific examination of materials required for these vast enterprises to quite narrow limits, and private laboratories were almost invariably entrusted with this important work.

With the establishment, in 1907, of the Water Board to build the new Catskill Aqueduct, a testing laboratory was inaugurated for the purpose of testing the materials used in its construction.

The Department of Water Supply, Gas and Electricity had a laboratory for water and gas analysis, and also for the examination of other materials used in the various branches of that department, including gas examinations by many photometric stations distributed over the city, and necessarily located where the gas supply from the various sources could be most advantageously obtained.

The laboratory of the Board of Health conducted the examination of water and all other examinations which are strictly within its jurisdiction.

It would lead too far to narrate all the details of the workings of, and results accomplished by, the two last-named laboratories, but it may be of interest to know that in total, there are some twenty-six small laboratories owned by the City of New York.

Excepting such subsidiary laboratories as mentioned above, it is obvious that much analytical work performed was being duplicated and favorable or adverse results were not available to the city at large, not even to those officials who could apply such knowledge to the benefit of the taxpayer.

For the purchase of supplies for the various departments and public institutions alone the City of New York expends approximately twenty million dollars per annum. These materials are bought either under contract or in the open market, mostly under rather vague and inadequate specifications, leaving to a great extent their acceptance or rejection to the judgment of an individual.

It was recognized that these specifications should undergo a thorough revision and modification. To this end, a Committee of Standardization, consisting of the mayor, the comptroller and the president of the Board of Aldermen was elected by the Board of Estimate and Apportionment. This committee in turn appointed a commission on standardization, for the purpose above stated. The writer was selected as one of the members of this commission.

In the very initial steps taken by the commission on standardization to modernize the specifications for supplies, and especially

to incorporate reasonable physical and chemical requirements by which the quality and components of these materials could be described and deliveries controlled, the co-operation and advice of a city-owned chemical and physical laboratory was found to be an unavoidable necessity. This led to the creation of the Standard Testing Laboratory by the Board of Estimate and Apportionment, in the spring of 1911, for the following purposes:

1. The testing of samples of all kinds of general supplies purchased by the City of New York for the use of the various departments, and for the purpose of securing a proper audit of all claims therefor.

2. The testing of all materials used in construction work and in the laying and resurfacing of pavements, roadways and sidewalks in the five boroughs of the greater city.

3. The carrying on, concurrently with the routine of general testing and along specific lines of the city's needs, of such research work as will give the various city departments the benefit of the best available scientific knowledge, worked out practically along definite lines suggested by the routine of general testing, as indicated herein.

4. The simplification of the work of auditing and inspecting claims for supplies and materials furnished the city under properly drawn specifications, prepared by the Commission on Standardization and promulgated by the Board of Estimate and Apportionment, for use by all city departments. Co-operation in preparing specifications and in auditing and inspecting claims for work done and supplies furnished thereunder, so that the city shall, by the faithful carrying out of all specifications, receive full value for money expended.

5. The gradual evolution of uniform methods and standard tests of all supplies and materials purchased for city purposes, and the promulgation to all city departments, by means of monthly bulletins, or otherwise, of the results of such tests, and the research work based thereon. The object of the dissemination of this information would be to enable city departments interested to know fully and accurately the results in efficiency and economy of the general practices prevailing and the experiments made by every other department. This would prevent mistakes made by one depart-

ment from being repeated in others, as at present, and make methods by which valuable results are obtained in one department available to all others. Under the present system each department is permitted to work independently, in comparative ignorance of what is being done by other departments.

6. The maintenance of records, showing the relative life and relative good, or bad, qualities of all materials used by city departments in construction work, especially of materials used in the laying of pavements and sidewalks, and in the making and surfacing of streets and roadways with macadam and road oils, wood blocks, asphalt, granite sets or other materials. These records to be so kept as to inform departments in charge of such work, not only as to the best and most suitable materials to be used, but to demonstrate, from actual tests of such roadways and sidewalks during a course of years, the reasons for their durability or lack of durability; information of this character to be disseminated from time to time in monthly bulletins, or otherwise, for the information of all city departments.

7. The furnishing to the corporation counsel's office of such technical data, taken from the results of tests and from the official records of such tests, as might be required from time to time, to protect the city's interests in legal actions for damages involving materials and supplies furnished to, and work done for, any city department. At the present time large amounts of money are annually expended for expert services and testimony in such actions for damages. It is submitted that such services and testimony could be furnished by the staff and official records of a standard testing laboratory, in a manner and with a completeness which would more efficiently and far more economically protect the city's interests than they are at present protected in all such legal actions.

Since its establishment the Standard Testing Laboratory is in temporary quarters in a loft building, corner West Broadway and Franklin Street, occupying the very limited space of only three thousand square feet. Its personnel is made up, at the present time, of a director, five chemists, seven coal samplers, also acting as laboratory helpers and cleaners, one clerk and one stenographer. Of the above staff, two chemists and four coal samplers have been added since January 1, 1912.

The new quarters of the Standard Testing Laboratory of the

City of New York will be located in the New Municipal Building, corner of Park Row and Centre Street, now in course of construction, and the new laboratories, when completed, promise to be the most complete and up-to-date institution of its kind in the United States, covering floor area of approximately 35,000 square feet. The planning and designing of this equipment is being done by the writer, in conjunction with the architects of the New Municipal Building, under the supervision of the Commissioner of Bridges, who has charge of its construction.

From June 19 until January 1, 1912, the Standard Testing Laboratory completed and reported upon 580 chemical and physical examinations of over seventy different kinds of materials for eighteen different departments of the city government, of which 418 samples were acceptable, and 162 did not meet the requirements.

Since January 1, 1912, four departments have been added, and, judging from the variety of materials submitted, it may be inferred that the variety of materials submitted for analyses will exceed two hundred during the present year, still leaving a vast amount of additional samples of materials of construction and supplies to be taken up as soon as the new quarters can be utilized and the necessary staff procured.

It is not the object of the writer to give any detailed statement as to results accomplished so far by our relatively small establishment. However, it may be of more interest to dwell upon the subject of organization and efficiency secured through the united efforts of the staff of the Standard Testing Laboratory, as it exists at the present time, without making reference to future developments.

Efficiency in a laboratory is produced by the capacity of the staff, application of proper methods and the adoption of modern appliances.

The selection of an efficient staff, although sometimes hampered by civil service regulations, should be considered the criterion in securing efficiency in a laboratory.

It is unquestionably preferable to employ chemists who are graduates in chemistry of recognized institutes and universities, and who have had a few years' experience in both analytical and industrial chemistry. Teaching in the numerous universities and schools of technology, in strict adherence to the established methods and theories of the individual instructors, tends to impress upon the

fancy of a student, and is apt to create in him a liking for one or the other branches of chemistry or its allied sciences, and as a rule he is apt to carry this inclination through all his professional career. This tendency leads to specialization in a line which the young man is more or less fond of and competent in, and it is very important, in the estimation of the writer, to concentrate the activity of such a man to this very sphere of specialty, because the field of chemistry is so large that it would be folly to expect any person to be proficient in or control the immense stretch of that science.

As a consequence, it is advisable, as far as permissible, to accumulate talent from as many schools of recognized standing as possible.

The clerical force in the Standard Testing Laboratory takes care of the commercial end, keeps all accounts, attends to all pay rolls, orders, time and other records, files and correspondence, entries and disposition of samples submitted for tests.

The selection of a competent stenographer with good schooling is quite important, as most of the correspondence is of a technical and scientific nature, and delay and repetition of work is caused if the stenographer has to consult the dictionary too frequently.

In the labor class of the Standard Testing Laboratory, are the coal samplers, under the immediate charge of a head coal sampler. They are thoroughly trained to take all the coal samples for testing, according to established rules. When not actively engaged in obtaining samples of coal, or immediately after their return to the laboratory, they are required to prepare the coal samples for analysis, clean glass apparatus and other laboratory utensils. They are also instructed to make minor physical tests such as flash point determinations, how to set up and take down distilling and extracting apparatus, and to perform many other duties which facilitate the work of the chemists.

Technical advice to the Commission on Standardization of standard specifications for supplies forms an important duty of the Standard Testing Laboratory. In order to obtain supplies of good quality in the open market at a fair value, and also to provide free competition, the specifications must be framed in such a way as to admit any commercial article of good quality with the exclusion of adulterants. It is often the case that the manufacturer or dealer is scared off by specifications which contain the composition require-

ments of the materials as determined by chemical analysis, and of which the ordinary layman has little or no knowledge. The necessity of having such requirements is, however, obvious, and the method adopted by the Standard Testing Laboratory in that respect, and hereinafter described, appears to have the approval of the honest contractor. For instance, in the preparation of specifications for olive oil, eight different samples of well-known brands of this material were obtained directly from the various importers or dealers. All of these samples were analyzed at the Standard Testing Laboratory and found to be pure commercial olive oil. The results of the analyses were tabulated together with the various trade marks of the oils, and the specifications so arranged as to admit all of these oils, which, as stated above, were all found to be unadulterated. When the importer or dealer was shown the analysis of his own oil, together with those of his competitors, and convinced himself that the specifications therefor admitted all of the eight brands, he readily agreed to submit a bid. Had this method not been introduced, he would never have made a bid under the specifications, and the city would be forced to pay a higher rate. Wherever possible, this scheme will be carried through in the future preparations of all specifications for supplies.

In order to keep the Finance Department posted as to the analytical results obtained by the Standard Testing Laboratory, a copy of each report is submitted to the inspection division of the finance department, which, upon receipt of an adverse report, takes immediate steps to stop payment. The head of the department from which the material analyzed emanated, as well as the Commission on Standardization, and the commissioner of accounts, who has temporary charge of the Standard Testing Laboratory, receives a copy of each report.

Owing to lack of facilities, a monthly bulletin cannot be published before the staff of the Standard Testing Laboratory is sufficiently increased. The benefit derived from the publication of laboratory results obtained will certainly be appreciated, not only by city officials, but by the public at large. The composition of commodities used in most households, which are sold to the public with enormous profits to the unscrupulous manufacturer, should be made known, and the public should be warned. A material, for instance, submitted a few weeks ago to the Standard Testing Labora-



tory by the inspection division of the finance department, and used in one of the city departments, for a dust preventive in sweeping floors and carpets, proved, upon analysis, to be composed of sand, sawdust, a small amount of calcium chloride, and a trace of naphthaline. This material is sold at ten cents a pound, while it can be produced in hundred pound lots for less than thirty-five cents.

Other methods producing efficiency in the Standard Testing Laboratory are the standardization of methods of taking samples for tests, such as coal, soap, paint, etc., a system of records of all kinds, standard forms for reports and notifications, and a filing system for reports. Standardization of the methods of analysis is another factor which produces efficiency in the Standard Testing Laboratory.

The Director is in continual touch with the chemists and every method of analysis to be employed is thoroughly discussed, and, when once established, deviations therefrom are only permissible with his knowledge and consent.

Just as important as the standardization of methods, to produce efficiency in the Standard Testing Laboratory, is the installation of the most up-to-date appliances and labor-saving devices.

The latest form of electrically heated and controlled oven for drying, etc., has been installed. The thermostat of this oven keeps the temperature constant to within a half degree. By means of this piece of apparatus, evaporations and drying operations, which formerly took from two to three days' time, can be made over night.

Advantage has also been taken of the fine control of temperatures obtainable by means of electricity in the installation of a water thermostat whose temperature is electrically controlled. This type of thermostat, a recent invention, will keep the temperature of the water contained in it constant to one two-hundredth of a degree. The apparatus is invaluable in the taking of specific gravities of liquids, a frequent and important determination.

Another labor and time-saving device is a large electrically-driven centrifuge, with a variable speed up to 2,500 R. P. M., regulated by a speed-regulating rheostat. The head of this machine has receptacles to hold anything from a test tube to a 500 cc. bottle, including separatory funnels. It is also provided with a steam jacket and a revolution counter. The advantages of a motor-driven large centrifuge are so well known that an enumeration of the frequent

instances of application appears superfluous. In order to save labor and time in the process of obtaining representative samples of coal from a cargo, a power-driven coal crusher, with a capacity of six tons per hour, mounted on a motor truck, has been added to the equipment of the Standard Testing Laboratory. Other modern, motor-driven, crushing, grinding and sifting machinery installed at the laboratory, added considerably to its efficiency. A vacuum drying apparatus is employed in the preparation of coal samples for analysis. A complete set of standard apparatus for the physical, microscopical and chemical examination of all classes of paper has also been installed, and is being constantly used. All the thermometers used are either certified instruments or they are calibrated and corrected at the laboratory with a standard normal thermometer. The same rule applies to viscosimeters and other instruments of precision. Titration with normal solutions, can be performed independently of sunlight, owing to the fact that the titration is done over milk plates set in flush with the top of the titration table, and illuminated from below by tungsten lamps. Much time is wasted if the chemist or physicist uses the ordinary arithmetical methods. Logarithms, ordinary and chemical slide rules, and calculating machines have superseded plain arithmetic at the Standard Testing Laboratory. It would be too lengthy to mention all the other automatic and labor-saving devices used in connection with performing extractions, evaporations, etc., which are mostly done over night.

Only few laboratories in this country visited by the writer offer the analyst any devices of safety or provide for proper ventilation and personal comfort. The efficiency of a laboratory can be increased by proper up-to-date ventilation and the installation of safety devices such as showers properly located, and asbestos capes in case a man's clothing catches fire, etc. There is ample provision made in the plans for the new Standard Testing Laboratory, and owing to superior arrangements throughout, it is hardly possible to predict how much more this new institution will excel the old one in "efficiency."

In summarizing the various duties to be performed by a standard testing laboratory to secure efficiency, the following results are to be achieved:

Preparing efficient specifications.

Assisting in efficient inspection of goods delivered.

Ascertaining the most efficient materials for use in construction or supplies for consumption.

Observing and experimenting by research or otherwise, the serviceability of materials; as for example: oils, asphalts, paints, etc.

Collating, filing and having available for reference precise information regarding the physical and chemical characteristics of materials and supplies, with a view to determining the most suitable articles of each kind for the purpose required.

Arming the city with expert testimony and expert information to defend the various suits brought by disgruntled contractors in the way of construction work or general supplies.